Hatchery-reared F2 Mekong giant catfish spent their time above hypoxic water in the Mae Peum reservoir, Thailand

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ABSTRACT
Juvenile and young hatchery-reared Mekong giant catfish *Pangasianodon gigas* have been released into reservoirs throughout Thailand. For the sustainable reservoir fishery of the giant catfish, new science-based fishery management measures are expected in Thailand, such as the establishment of protected areas. Therefore, the habitat use and movement patterns of the hatchery-reared giant catfish have been investigated in the Mae Peum reservoir from 2003 to 2005. Our results suggest that the hatchery-reared fish spent their time in shallow depths above hypoxic water in the reservoir. The fish which have been reared in a fish pond may recognize and avoid hypoxic conditions.

KEYWORDS: MCTP, *Pangasianodon gigas*, vertical movement, acoustic telemetry

INTRODUCTION

The Mekong giant catfish is an endemic species to the Mekong River Basin (Akagi et al. 1996, Rainboth 1996, Hogan 2002). This catfish is one of the largest freshwater fishes in the world, measuring up to 3 m in length and weighing more than 300 kg (Rainboth 1996, Mattson et al. 2002, Hogan 2004). Historically, this species was distributed throughout the basin from China to Vietnam, but it now appears to be limited to the Mekong River and its tributaries in Thailand, Lao People's Democratic Republic (Lao PDR), and Cambodia (Hogan 2004). In Southeast Asia, this giant catfish has been popular food for the local people, and is one of the most important and high-value fishery species (Akagi et al. 1996). However, the catch number of wild catfish in the Mekong River has declined due to development of the river and over-fishing (Poulsen & Viravong 2002, Hogan 2004). At present, the catfish is listed in the Convention on International Trade in Endangered Species (CITES) Appendix I and on the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List of threatened species as a Critically Endangered Species.

In Thailand, an artificial propagation technique for the catfish (F1) was developed in 1983 (Mattson et al. 2002), and a second generation of catfish (F2) was successfully produced in 2001 (Pawaputanon 2007). Both F1 and F2 hatchery-reared juvenile and young immature catfish (Figure 1) have been released by the government of Thailand (Pawaputanon 2007) into lakes and reservoirs (e.g. Mae Peum reservoir Figure 2) in Thailand as fishery resources for local people. Giant catfish have recently been harvested from reservoirs by local fishermen and have been valuable in market trade (Mattson et al. 2002). Given the need for sustainability of the giant catfish fishery in reservoirs, fisheries research will be indispensable for science-based fishery management measures such as the establishment of protected areas for fisheries (residential and spawning areas), closed seasons, and regulations for fishing gear (Bhukaswan 1980, MRC 2005, Pawaputanon 2007).

Fig. 1 Hatchery-reared Mekong giant catfish.

A detailed understanding of the habitat use and movement patterns of fish species can contribute to effective fisheries management through the use of protected areas (Humston et al. 2005, Topping et al. 2006). Therefore, we have investigated the habitat use and movements of the F1 and F2 giant catfish in Mae Peum reservoir from 2003 to 2005 (Mitamura et al. 2006a, 2007, 2008, 2009). These studies were performed within the context of the Mekong giant catfish tracking project (MCTP) to conserve and manage its species (Arai et al. 2005).

In the previous proceedings, we reported horizontal movement patterns and the habitat use of the hatchery-reared (F1 and F2) giant catfish

(Mitamura et al. 2006b, in press) as well as vertical movement patterns of the hatchery-reared (F1) catfish in the Mae Peum reservoir (Mitamura et al. 2005, 2006b). In this paper, we introduce vertical movement patterns of the hatchery-reared (F2) giant catfish in the Mae Peum reservoir.

a)

b)

Figs. 2 Photos of the Mae Peum reservoir in September 2005 (a) and in December 2005 (b).

MATERIALS AND METHODS

Mae Peum reservoir

The Mae Peum reservoir (area approximately 8.3 km^2, maximum depth approximately 15 m) is located in the province of Phayao, Thailand (Figures 2, 3). The water level of the reservoir is regulated by overflow and was mostly stable during the year of the study. Local fishermen harvest the giant catfish as well as other fishes using gill nets in the reservoir. Algae as a potential food source for herbivorous giant catfish are abundant along the shallow inshore areas of the reservoir.

Fish and tagging

All fish used in the study were immature second generation (F2) hatchery-reared fish that were produced by artificial propagation using first-generation (F1) hatchery-reared fish. The F2 fish had been reared in the fish pond (40 x 80 m, 1 m deep) after artificial propagation. The average $\pm$ S.D. body length of the fish was 63 $\pm$ 2 cm. On 30 August 2005, ultrasonic coded pressure-sensitive transmitters (V9P-1H: Vemco Ltd., Halifax, Nova Scotia, Canada; 9 mm in diameter, 40 mm long, and 2.7 g weight in water; 69 kHz, depth accuracy: ±20 cm, transmission interval: 40–120 s) were surgically implanted into the peritoneal cavity of fish under anaesthesia that was induced using 0.1% 2-phenoxyethanol. The wound was closed using an operating needle and sutures, and the antibiotics oxytetracycline hydrochloride and polymixin B sulphate were applied. A previous experiment demonstrated that intra-peritoneal implantation had no discernible effect on survival or growth over a period of approximately 2 months (Mitamura et al. 2006a).

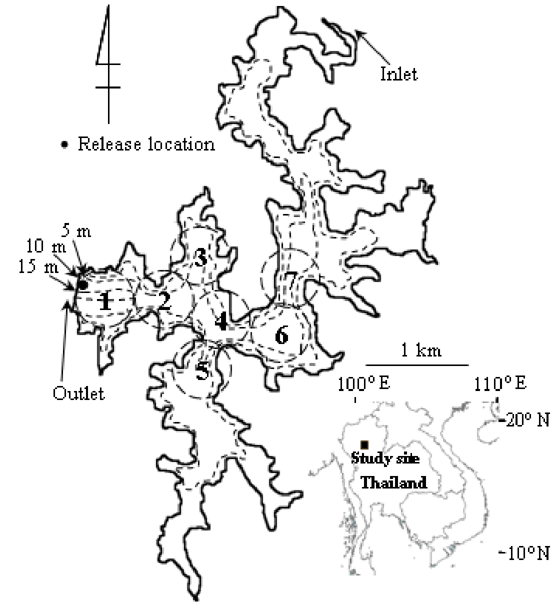

Fig. 3 Map of the Mae Peum reservoir in the province of Phayao, Thailand. The numbers (1-7) represent the locations of monitoring receivers. Dashed circles represent the expected signal detection range of the coded ultrasonic transmitters. The small filled circle represents the location of fish release.

Monitoring system

Seven fixed monitoring receivers (VR2 system: Vemco Ltd.) were used to monitor the tagged fish (Figure 3). The monitoring receivers logged data on the presence (identity, ID) and swimming depth of all tagged fish. Each receiver was moored at mid-water depth (5-7 m) for 100 days from 1 September to 9 December 2005. See more detail in Mitamura et al. (2009).

Water temperature and dissolved oxygen

Vertical profiles of water temperature and dissolved oxygen (DO) were measured at seven sites (receiver stations) in the reservoir in the daylight on 7 September and 9 December 2005, using a DO meter (Model 550A, YSI/Nanotech Inc., Kawasaki, Japan; temperature accuracy: ±0.3°C, oxygen accuracy: ±0.3 mg L^{-1}, Figure 3).

RESULTS AND DISCUSSION

The fish spent their time in shallow depths during the study period. The fish swam in a shallower layer than 4 m in September while the fish also utilized a deeper layer than 4 m in December (Figure 4). The depths of DO stratification (3–4 m deep) in a day in September of the study year corresponded to the maximum fish swimming depth (Figures 4, 5). The DO stratification in a day in December of the study year became deeper, and the fish swimming depth also increased (Figures 4, 5). The temperatures between the surface and the bottom in December (< 2 ^{o}C) were very similar and likely did not affect fish behaviour. These results, in spite of the small number of environmental data, suggest that hypoxic water in the deep layers may limit the vertical movement of fish. (See the detail in Mitamura et al. 2009).

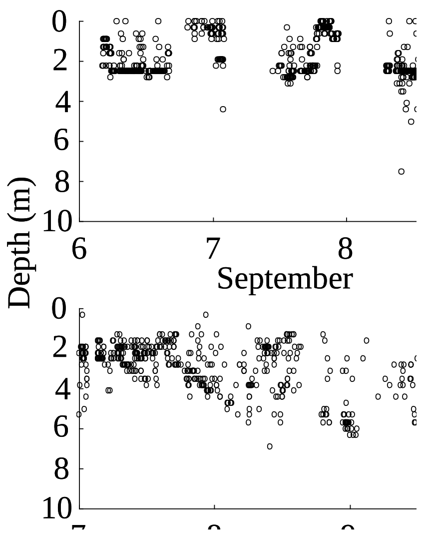

Fig. 4 Typical vertical movements of a tagged fish in September and December 2005.

The tagged fish which had been reared in the fish pond survived for more than 3 months in the reservoir. The tagged fish may recognize and avoid hypoxic conditions, generally exposure to which for a long time may have a large effect on fish behavior and respiration activity and may eventually lead to death. Similar movement patterns in relation to hypoxic water have also been observed in F1 hatchery-reared Mekong giant catfish (Mitamura et al. 2008). These indicate that catfish may be cultivated in the reservoir for the sustainable fishery.

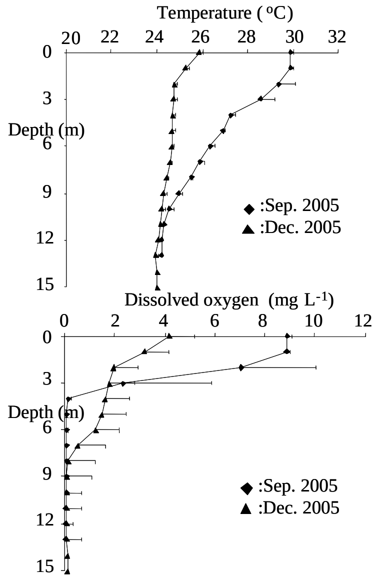

Fig. 5 The upper and lower figures show the vertical distributions of temperature and dissolved oxygen in September and December 2005, respectively.

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